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MODELLING INDIVIDUAL PREFERENCES: STATE OF THE ART, RECENT ADVANCES AND FUTURE DIRECTIONS

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1. INTRODUCTION

"De gustibus non disputandum est" (Anonimous)

Despite the above famous statement, individuals have always disputed about individual tastes, and the decision making processes behind consumers' choices has been a focal interest for decades. Although challenges against the theory of rational behaviour date back to the work of von Neumann and Morgenstern (1944), the dominating approach (at least in the transport field) has been the neoclassical economics assumption of rational decision makers (or even more extreme *homo economicus*), who always perform well planned and consistent activities, aiming to maximize some subjective measure of value (McFadden, 1999).

The reason for this dominance is that economic theory has provided an elegant, rigorous and at the same time relatively easy to implement model, designed to describe individuals' decisions and to provide quantitative forecasts with well-defined statistical properties. On the other hand, although investigations in psychology have made an impression on economic thought[1], they have tended to generate lists of errors and biases and have mostly failed (with excellent exceptions) to offer a coherent alternative to the rational-agent model (Kahneman, 2003). Psychologists recognise that this complaint is justified, at least partly, because intuitive thought cannot match the elegance and power of formal normative models. However, as Kahneman (2003) points out … "the alternative to simple and precise models is not chaos; psychology offers integrative concepts and mid-level

[1] McFadden (1999) uses a powerful description for the feelings of those economists in front of the new evidence coming from psychology: "*it has been like watching master carpenters to construct the scaffold for your hanging*".

generalizations, which gain credibility from their ability to explain ostensibly different phenomena in diverse domains".

The origin of this divergence relies on the historically different views of the decision-making process between neoclassical economics and psychology. While economists have been interested in mapping from information inputs to choice, treating the decision process as a *black box*, psychologists' prime objective has been to understand what happens inside that black box: the nature of these decision elements, how they are established and modified by experience, and how they determine values. McFadden (1999) notes that what has made the distance between the two approaches even bigger is that psychologists view the decision process as dynamic and individual behaviour as local, adaptive, learned, dependent on context, mutable and influenced by complex interactions of perceptions, motives and attitudes. On the other hand, in the economic tradition preferences are primitive, consistent, and immutable (*preference rationality*), consumers behave *as if* they possess the formal tools with which to calculate the optimum adequately (*perception-rationality*), and the cognitive process is simply preference maximization, given market constraints (*process-rationality*).

The models that we (transport researchers) currently use to describe how people choose among a discrete set of alternatives are based on these assumptions of rationality in *preference, perception and process*. McFadden's work (1978; 1981) on Generalised Extreme Value (GEV) formulation, which generalised the work of Williams (1977), provides a rigorous foundation for consumer choice modelling derived from economic theory. Although the original formulation of the random utility maximisation (RUM) as a behavioural model followed the economists' theory of consumer behaviour, it also included "features of the taste template that were heterogeneous across individuals and unknown to the analyst, as well as unobserved aspects of experience and of information on the attributes of alternatives, interpreted as random factors" (McFadden, 2000). This led to the paradigm for generating discrete-choice models (DCM), commonly reported in textbooks (Ben-Akiva and Lerman, 1985; Ortúzar and Willumsen, 2011; Train, 2009), that the random part of the individual utility reflects the modellers' lack of complete information about all the elements considered by the individual making a choice, which might also include unobserved deviations of individual behaviour from perfect rationality.

This paradigm posed the bases for the most important stream of research of the last 30 years. Since McFadden's work, in fact, research activity in this field has been very proactive. Major progress has been made in exploring the potentiality of DCM to improve the ability to effectively reproduce individual behaviour. In particular, this paper draws attention to two streams of research motivated by this work. The first refers to the microeconomic justification of DCM and, in particular, of the utility individuals associate to each discrete alternative. The second stream, and maybe the most productive one, has been concerned with the characterization of the error terms, and in particular the exploitation of the mixed multinomial logit (MMNL) model.

Research in both streams has aimed to improve the representation of the true phenomenon. However, the goal has always been that the measurable part of utility should be able to explain (as much as possible) the true behaviour in order to reduce the

explanatory power left in the error term. This is correct except that, under the neo-classical theory, the systematic measurable utility was associated only with "rational" behaviour and what deviated from it was classified as error and hence minimised. Unfortunately, major improvements in model fit obtained with complex decompositions of the error term have given a strong signal that there are inherent limitations in the capability of microeconomic theory to explain individual choices and that we are still far from having a satisfactory representation (through known variables) of the real phenomenon. In fact, although RUM "takes a nod towards psychological theory" (Batley and Daly, 2006), the error term cannot be considered to properly explain behaviour that departs from perfect rationality. This is because errors are parameterized in terms of statistical distributions and the psychological concept of *irrationality* (i.e., not rational in the sense of neoclassical economic theory) is associated to the concept of randomness. As suggested by Ariely (2008), apparent irrationality can indeed be explained and predicted.

Illustrious scholars (McFadden, 2000; Ben-Akiva, *et al*, 2002a) have strongly asserted the need to explore more seriously the suggestions provided by the psychological literature. After a shy start, the last decade has seen a surprising increase in the amount of work in this area (see for example Walker, 2001; Gärling and Axhausen, 2003; Bonsall, *et al*, 2007). Most of it has concentrated on demonstrating empirically that integrating psychology theory into the economic framework results in tangible improvement in terms of model fit, and interestingly most of it has been based on the MMNL structure. This is a key point, because the last years have also witnessed an increased awareness of the inherent limitations of the MMNL in terms of both estimation and especially prediction. In fact, notwithstanding the clear ability of this model to represent an ample range of behaviours via error term decomposition, several problems implicit in its structure have led analysts to lose confidence in the model. It is interesting then to understand whether or not these new models, which go beyond the rational postulate, still suffer from the above limitations or to what extent these are overcome.

This paper presents a critical review of the research developments in the representation of the decision process, and it is structured into two parts. The first is dedicated to reviewing the limitations of the DCM and, in particular, of the MMNL model. Limits due to both the microeconomic theory of the rational user and the exploitation of the error terms will be critically discussed. The second part of the paper reviews research belonging to the non-rational theory. I concentrate on those advances that still rely heavily on the DCM with the aim to discuss to what extent we are really moving forward with respect to the above limitations of the classical MMNL model. Although focusing on research produced in the transport field, the paper provides and relies on several references from the literature in psychology and behavioural economics.

Placing an accent on the limitations of current theory is not dictated by a pessimist view. On the contrary, it is intended as a proactive approach; these limitations constitute the starting point for and, above all, should stimulate new research. Another important consideration is that excellent reviews of both microeconomic theory (see McFadden, 2000; Bates, 2007; Jara-Díaz, 2007) and discrete choice models (see Ben-Akiva, *et al*, 2002b; Ortúzar, 2006; Bhat, 2007) already exist, while a review of their limitations seems

yet to be undertaken; at least this is what emerges from research conducted over the last few years.

The paper concludes by discussing some open questions raised by the research conducted so far and giving some final thoughts about the amazing challenge unfolding before us over the next years.